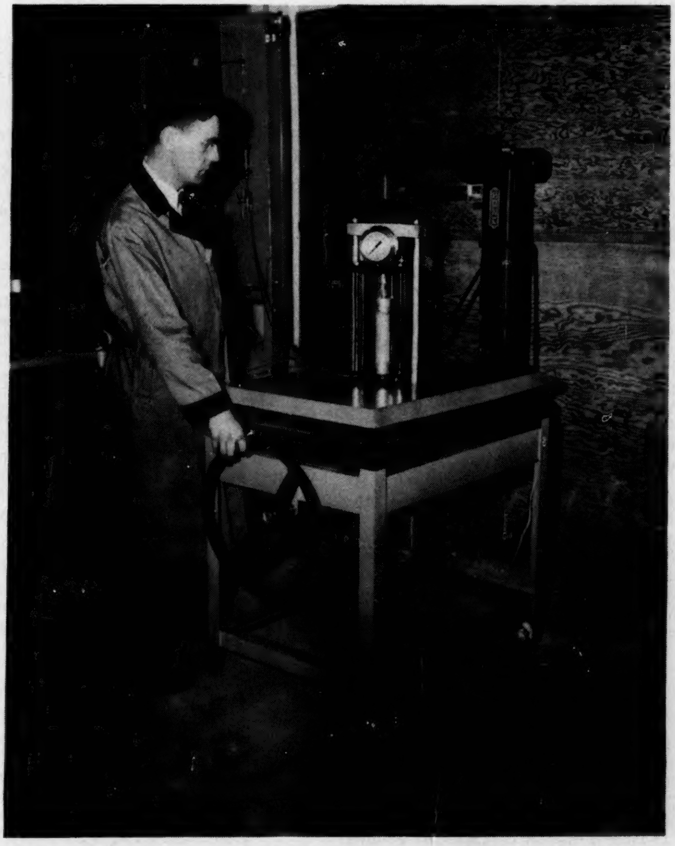
STATE ENGINEERING EXPERIMENT STATION

The Research Engineer

GEORGIA INSTITUTE OF TECHNOLOGY

SEPTEMBER ATLANTA, GEORGIA 1948



The Research Engineer

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WHAT'S IN A NAME?

As is common knowledge by now, the Georgia *School* of Technology on July 1, 1948, became the Georgia *Institute* of Technology, with the official sanction of the Georgia Board of Regents. This action, approved by faculty, students, and alumni alike, was taken in order to bring the name of "Georgia Tech" into fuller conformance with the titles of similar engineering and scientific institutions of higher learning. Since the various departments of Georgia Tech have in themselves been "schools" in every sense of the word, only tradition had to be considered before making this change.

No learned discussion seems warranted here on the meaning or meanings of "institute," but it does seem worthy of note that three Georgia Tech-associated groups also employ that term in their titles, and it may well be that many are not entirely clear as to the distinction between these groups and others which have closely related names. For this reason, the following list of brief sketches has been prepared.

The GEORGIA INSTITUTE OF TECHNOLOGY is the engineering institution of higher learning of the University System of Georgia. It comprises engineering and general colleges, under which are the various engineering and scientific schools, related departments, and the Division of Graduate Studies, which has charge of graduate-level education and research.

The STATE ENGINEERING EXPERIMENT STATION, often called the Georgia Tech Engineering Experiment Station, is that division of the Georgia Institute of Technology which is charged with the proper utilization of the Institute's facilities for the promotion of research within the Institute, for the benefit of industry, and for the more complete utilization of the natural resources of the state, in addition to the advancement of knowledge.

The GEORGIA TECH RESEARCH INSTITUTE is a separately incorporated organization which is closely associated with Georgia Tech and which serves primarily as the contractual and "business" agent for industrial and other "outside" research conducted here.

The GEORGIA TECH ALUMNI FOUNDATION is a nonprofit educational organization set up to administer funds made available by various industries and by friends of the Georgia Institute of Technology, these funds being used to make possible scientific and economic research and investigation, to develop industrial tests, to promote engineering and scientific education, to foster educational and industrial cooperation, and to provide Georgia Tech with modern equipment and facilities.

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ENGINEERING DESIGN AS AN IMPLEMENT OF RESEARCH

By R. A. Hall*

The design and development of mechanical devices is usually considered as an engineering field in itself. However, in a research laboratory such work is often uniquely related to the various other sciences in the sense that it provides specialized facilities which are otherwise unobtainable for the construction of experimental apparatus, the development of new or improved types of machinery, and the commercial development of devices covered by existing patents of a mechanical nature. In the following article, these and other relationships are described and illustrated in terms of specific examples taken from the project files of the Georgia Tech Engineering Experiment Station.

When the Engineering Experiment Station was established at Georgia Tech in 1919, its purpose was to "make tests and investigations in any or all branches of engineering, manufacturing, and the industries and sciences related thereto."[1]

This is, in itself, quite a large order, and, when one considers the present-day complexity of even a single branch of engineering, it is readily apparent that an organization which is to be adequately prepared to conduct research in *all* such sciences must be extremely flexible, and versatile to a degree that is seldom encountered elsewhere. However, this is exactly what is expected of the Georgia Tech Engineering Experiment Station, and is also the reason for its location on the campus of Georgia Tech — in order that the various members of the faculty might be available to augment the Station's staff, whenever necessary. In this manner a vast reservoir of scientific and engineering ability is provided, including practically every major branch of science.

The work of the Station, as might be expected, involves the integrated efforts of several specialized divisions. Contractual matters, for example, are usually handled through liaison with the Georgia Tech Research Institute. Various matters concerned with reports, patents, and publications are dealt with by the Technical Information Division, which also serves to provide projects with informational searches and reports. Actual research projects in engineering and scientific fields are directed by specific project directors who are either full-time Station employees or members of the Georgia Tech teaching faculty.

In connection with its research activities, the Station long ago felt the need for an adequate machine shop, and, when this had been developed (see Figure 1), found itself called upon to solve problems of mechanical design which were not of a routine nature. Faculty members of such Georgia Tech schools as those of Mechanical Engineering and Aeronautical Engineering were and still are often called in to direct work of this type, but a need was felt for the creation of a responsible group to centralize this type of endeavor, and an Engineering Design Division was created.

In general, the work of the Station's Engineering Design Division may be classified in four categories: (1) original design and development of major mechanical devices, (2) development of mechanical equipment in accordance with the requirements of a larger research program, (3) design and construction of specialized scientific appara-

Figure 1. Partial view of Engineering Experiment Station machine shop.

* *Chief, Engineering Design Division, State Engineering Experiment Station, Georgia Institute of Technology.*

Figure 2. Improved model of high-speed seed planter, arranged for chain and sprocket drive from tractor.

tus, and (4) development of existing, patented devices into practical, commercial machines.

MAJOR MECHANICAL DEVICES

Work of this nature usually constitutes a research project in itself, and is ordinarily undertaken in response to the specific need of some "outside" organization or individual after investigation has disclosed that no facilities are available elsewhere. In many instances, a preliminary engineering study is made in which the problem is outlined and a tentative solution presented before actual work is begun. Monthly progress reports are then submitted as the work proceeds; these furnish the sponsor with a complete picture of the status of his project at all times.

Since many of the devices thus developed comprise new or improved features, their patentability is not overlooked. Working in close conjunction with the Technical Information Division, patent searches are procured and records of invention are prepared on every device which incorporates originality of design. In the event that a patent is granted, all rights are usually assigned to the sponsor of the project.

This type of work may be illustrated by the development at Georgia Tech of a high-speed seed planter, previously described in this publication.[3] This machine was developed at the request of the Georgia Agricultural Experiment Station to meet the need of modern large-scale farming operations which have rendered obsolete the old-style, horse-drawn planter. In this case, the solution was achieved by an entirely new type of seed pick-up and delivery mechanism developed after extensive experimentation with conventional planters, and specifically

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SOIL MECHANICS — A NEW TOOL FOR CIVIL ENGINEERS

By G. F. SOWERS*

Soil mechanics is that branch of engineering science that deals with the structural properties of soils and soil masses. It involves the geology of soil deposits, the hydraulics of water flowing through a porous medium, the physical chemistry of soil materials, and the mechanics of soil masses. Georgia Tech is believed to be the first engineering institution in the Southeast to recognize the need for thorough advanced training in this field and to incorporate its study into both the undergraduate and graduate curricula in civil engineering.

Modern soil mechanics is rapidly becoming an indispensable tool for the engineer and contractor. Until about twenty years ago, most practical engineers believed that foundations, earth dams, excavations, and earth fills could not be analyzed scientifically, but since then intensive study in both Europe and the United States has shown that soil problems can be analyzed in a manner similar to other structural problems.

All civil engineering structures, whether dams, bridges, buildings, highways, or sanitary facilities, rest ultimately on soil or

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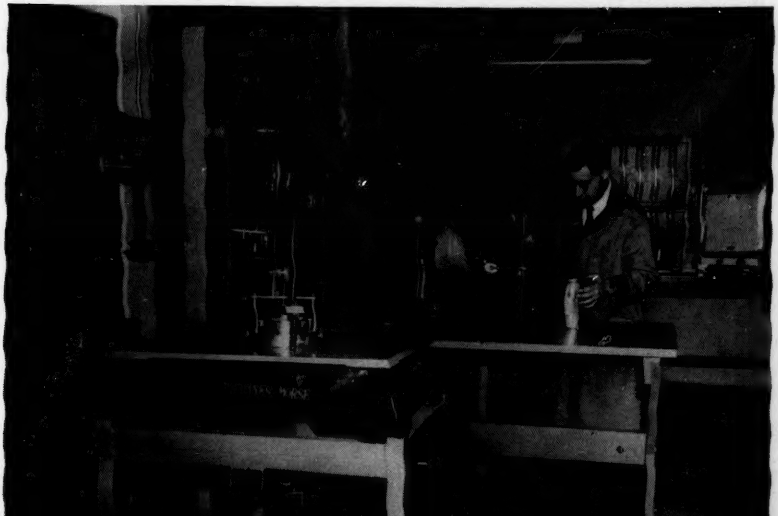

Figure 1. General view of the Georgia Tech Soil Mechanics Laboratory.

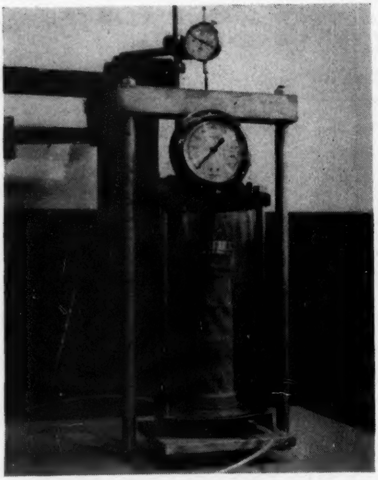

Figure 2. Triaxial compression of soil sample.

rock, and some of these structures themselves may even be constructed from such materials. As a result, soil mechanics is of importance to nearly every other phase of civil engineering. A satisfactory building or bridge foundation cannot be designed without a study of the underlying soil and its ability to carry the loads without failure or excessive settling. Dams and levees impound water to heights above the normal water table, and the effects of this water pressure in the soil must be studied to determine leakage or possible foundation failures of the dams. In addition, earth dams or levees involve some special stability and seepage problems of their own. Highway fills, airports, and earth dams all involve the use of the soil as a material of construction. Methods have been developed to design mixtures of soils for these structures and to control their construction. Soil mechanics is a big aid to the contractor who must make excavations, construct tunnels, and erect buildings close to existing buildings. A knowledge of soil mechanics makes possible the prediction of difficulties such as cave-ins far in advance and permits the application of methods for their correction.

DEVELOPMENT HISTORY

Why, then, has soil mechanics been so long neglected, if it is such a useful science? The answer lies in the history of its development. In reality, the study of soils, and particularly of foundations, goes back as far as the study of other branches of civil engineering. The Romans founded their buildings on piling; the medieval church architects and builders made use of spread footings and developed rules for their design.

Theoretical soil mechanics, the study of the mechanics of soil masses, began with Coulomb and other physicists who are well known in fields of electricity and mechanics. They began their studies with crude experiments on piles of sand and from them developed mathematical relations for earth pressure on retaining walls and the bearing capacity of foundations. This procedure was logical, and, when applied to other problems in mechanics, led to theories that are still in good repute. Such theories developed for soils, however, proved to be dismal failures. Retaining walls failed, buildings settled, and excavations caved in when designed in careful accordance with theory.

When this occurred, engineers and builders turned away from theory and made use of their past experience with soil structures to build up empirical rules governing their design. Many of these rules are embodied in our present building codes, which permit, for instance, a foundation pressure of two tons per square foot on "firm clay" soil. However, failure of buildings, bridge foundations, levees, and dams continued at such a great rate, in spite of these rules based on experience, that agencies of the United States Government and foreign governments, universities, and construction organizations began intensive soil research that is continuing today. Much has been learned, and much remains to be discovered, but the science of soil mechanics has already proved its worth in the design of bridge foundations, building foundations, dams, and in many phases of construction.

SOIL PROPERTIES

The greatest obstacle to the understanding of the mechanics of soil masses has

been a lack of understanding of the physical properties of soil itself. Soils are natural physical mixtures of solids, liquids, and gases of many different compositions, mixed in almost any proportions. Because of this, their range of physical properties is almost infinite. When it is further remembered that a soil deposit is made up of many types of soil in irregular layers, the complexity of the problems involved can readily be understood. The chief fault of the early theories was that they applied only to the piles of sand that were used in the experiments. Engineers, assuming then that all soils were similar, attempted to apply these theories to silts and clays that in no way resemble sands. It is no wonder that failures resulted.

Modern research on soil mechanics began with a study of the physical properties of soils. Old theories were examined to determine their range of applicability to soil problems. Many have been reaccepted, such as Coulomb's theory of earth pressure on retaining walls, which applies to dry sands. Others have been modified in the light of better knowledge of soil properties, while still others have been discarded completely. In addition, empirical rules have been analyzed; some have been found to have a sound rational basis, while others are definitely in error. New theories are being developed to aid in analyzing many of the unsolved problems in soil engineering, making use of new knowledge of soil physics. In this work, the soil mechanics laboratory at Georgia Tech will have a part, as outlined later.

The starting point for all studies involving soil masses is the determination of the properties of the soil. This is done either by laboratory test or by tests of the soil in the field, whichever method is most convenient and will give the most reliable results. Field testing has the advantage of utilizing the soil as it actually occurs in the ground, but the difficulties in getting the proper equipment to the soil to be tested (especially if it is far underground) usually rules out this method. Laboratory testing can be done under carefully controlled conditions with elaborate equipment, and, if the soil samples are representative and correctly secured, results are comparable to those obtained from field tests.

These latter tests usually involve either the testing of the bearing capacity of foundations or seepage determinations through soils underlying a dam or levee. Such tests are extremely expensive and are used only when laboratory tests cannot give satisfactory results. Typical of such methods are bearing capacity tests for foundations, which have been used for years and were standardized by the American Society of Civil Engineers in 1920. The test method is simple: a rectangular plate, usually one or two feet square, is loaded in small increments until the pressure on the soil is far above the pressure to be exerted by the bridge or building to be erected. This test involves so many technical difficulties in its conduct and in its interpretation that in many cases the results are worthless. With great care and intelligent analysis, however, the test can sometimes furnish a basis for design.

Laboratory tests are of three types:

1. Engineering tests, made to determine the strength, compressibility, or permeability of a soil.

2. Control tests, conducted in order to determine the proper use of a soil for fills,

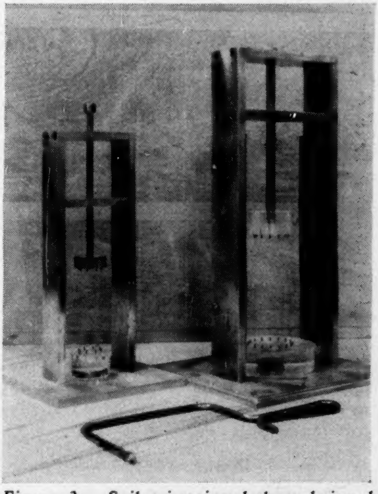

Figure 3. Soil trimming lathes, designed and built at Georgia Tech.

embankments, earth dams, or highway subgrades.

3. Index tests, performed in order to classify soils into groups having similar engineering properties.

ENGINEERING TESTS

The engineering tests are by far the most important in the design of foundations, retaining walls, and earth levees and dams. Failure of soil under structures occurs by shear, and various types of shear tests are therefore in general use. The best and most flexible method is "triaxial shear," in which a cylinder of soil is subjected to compressive forces on all sides. Failure is produced by increasing the axial compression while holding the lateral compression constant. The equipment for the test is complicated, because all pressures must be adequately controlled and readily measured.

Compressibility is determined by a consolidation test. In this test, a disk of soil, surrounded by a heavy brass ring, is squeezed under pressure up to 40 tons per square foot. The amount of compression and the time rate of compression of the sample are used to predict settlement of structures resting on the soil.

Permeability testing determines the ease with which water passes through a soil. The method is simple, since it involves only subjecting an encased sample to water under pressure and determining the rate of flow, but the equipment must be adaptable to the extreme range of permeabilities found in natural soils.

CONTROL TESTS

Control tests determine the manner in which a soil should be used as a raw material. Usually, such tests are limited to finding the correct conditions for compacting the soil as it is placed to form the structure. The method is purely empirical: samples of the soil are compacted in the laboratory by methods simulating field conditions. Other tests check the fill during construction to see that it is meeting requirements.

INDEX TESTS

The index tests are a heterogeneous collection of methods borrowed largely from agricultural scientists to determine grain sizes, moisture-holding capacity, and plasticity characteristics. It has been found by experience that soils having similar index properties have similar engineering properties. Index tests are simple and inexpensive to conduct in comparison with the engineering tests, and so are often used to classify soils for engineering tests or for preliminary studies of engineering properties.

GEORGIA TECH LABORATORY

The new Soil Mechanics Laboratory at Georgia Tech has equipment for all recognized laboratory tests. Some of the apparatus is of the type standardized by the American Society of Testing Materials and was available from commercial instrument makers. Most of the apparatus, however, particularly that for the engineering tests, is not commercially available in satisfactory form and thus had to be designed and constructed at Georgia Tech. Conventional designs were simplified to permit easy cleaning and simplicity in handling. Aluminum, stainless steel, and Lucite (a transparent plastic) were used throughout to avoid rust and to maintain light weight. Lucite has been used extensively in the construction of small parts because it is readily drilled, tapped, and formed with ordinary hand tools.

The heart of the engineering tests are three compression machines, each capable of exerting pressures up to 3000 pounds per square inch with an accuracy of 0.25 pound.

The testing equipment for triaxial shear is extensive, permitting tests of all soils under a wide variety of conditions; this device is shown on the cover of this issue. Two triaxial compression cylinders are available for testing soil samples under lateral pressure from compressed air and axial pressure from the loading machine. One cylinder is designed for 2.8-inch diameter soil samples and the other for 1.4-inch diameter samples. Special simplified apparatus has been constructed for triaxial tests of sand, using an internal vacuum rather than external pressure on the sample. Radically simplified trimming

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THE STATE ENGINEERING EXPERIMENT STATION 1947–1948

This article is a condensation of last year's "Annual Report of the Director," Gerald A. Rosselot, to the President of the Georgia Institute of Technology. It contains an account of the Station's continued growth and technical progress during the past fiscal year.

As in the past, State Engineering Experiment Station activities continued their regular expansion during 1947–1948, and the Station had the busiest year since its formation. The research budget of over $420,000 represented an increase of almost $100,000 over that of the previous year; of this budget, however, only $60,000 (14 per cent) was provided by the State (through the Institute), while $360,000 was provided by outside agencies — private companies, industrial groups, government agencies, the armed forces, and individuals.

Research was conducted on 40 major research projects and 24 minor projects or special jobs, requiring the full-time services of 75 persons and the part-time services of 137 other individuals; approximately 17 major projects and 18 problems of lesser magnitude were inaugurated during the year. Many of these were for industrial sponsors, and a number of the problems are of particular interest to Georgia. Extensive research connected with the national defense is being conducted under the sponsorship of the armed forces.

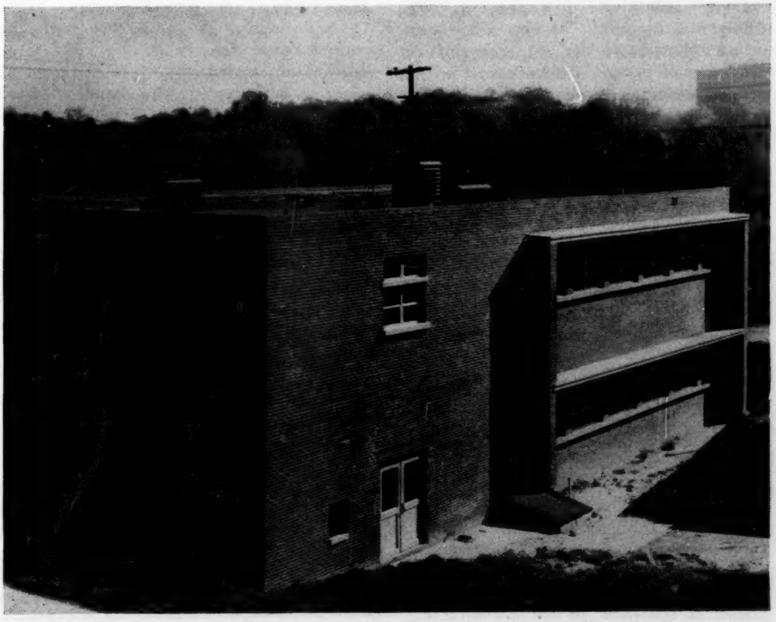

Figure 1. The part of the Research Annex completed in November, 1947.

New additions to the Station's staff include a second assistant director (with the rank of associate professor), three research associate professors (who are devoting at least two-thirds of their time to Station work), six research engineers, and several research and technical assistants. The technology of fine particles and the operation of a-c network calculators are the fields of specialization of two of the most outstanding of these men, many of whom are also participating in Georgia Tech's graduate studies programs, both in instructional and thesis directional work. In this manner, Station-sponsored as well as outside-sponsored projects aid materially in the strengthening of the Institute's growing Graduate Division.

NEW FACILITIES

During the past year, part of the much-needed Station Annex was completed, and a $150,000 a-c network calculator (the largest in the country) was installed in this building and placed in operation. The Annex also houses, at present, a low temperature laboratory for the study of the properties of matter at temperatures within a few degrees of absolute zero and a specialized laboratory for the study of fine particles and emulsions.

Several temporary buildings were constructed for the use of a large-scale radar project, whose special equipment is valued at over $200,000. At a site somewhat removed from the Research Building, a group of special buildings were constructed for use on research projects dealing with explosives and propellants. An air-conditioned weave room was constructed in the Textile Engineering Building, a fully equipped radar transmitting station with three operating frequencies was installed atop the Physics Building, and considerable new equipment was built and installed in the Aeronautical Engineering Building.

A laboratory for research on oilseeds and cellulose and wood chemistry has been set up in one of the temporary buildings, and a new semipilot plant for production of manganese dioxide is under construction in another. A new liquid air plant has been placed in operation in the Chemical Engineering Building.

The Station is badly in need of additional low-head-room laboratory space, especially if further expansion is to be made in certain types of project operations. Completion of the entire Station Annex in the very near future is a "must."

SERVICE DIVISIONS

The Station's ENGINEERING DESIGN DIVISION (described in detail in another article in this issue) has continued to provide the majority of the mechanical design and drafting required by the various Station projects, to serve as a control point for work handled by the machine and fabrication shops, and to assist the Technical Information Division in preparing records of invention on mechanical devices.

Background information needed for the proper conduct of various research projects continues to be provided by the TECHNICAL INFORMATION DIVISION, which prepares, on request, literature and patent searches and summaries. Such services are also available to outside groups. This Division, during the year, was made the control center for the editing and reproduction of Station reports to sponsors of research projects. It also handles patent matters concerned with Station research programs, edits THE RESEARCH ENGINEER, edits Station publications and handles their distribution, and prepares publicity releases and exhibits.

During the past year, the Technical Information Division completed several exhaustive literature and patent searches in the fields of dry cell technology, solvent extraction of oleaginous materials, preservation of foods by freezing, water and sewage analysis, oil re-refining, spindle lubrication, and others which cannot be listed. The first four of these searches have been made generally available through publication as Special Reports.

The PHOTOGRAPHIC AND REPRODUCTION LABORATORY, activated last year, has considerably expanded its service potentials and now provides photographic, developing, printing, enlarging, photostating, ozalid, mounting, layout, and other services to the Station and to all departments, organiza-

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THE GEORGIA TECH SANITARY ENGINEERING LABORATORY

By GEORGE W. REID* *and* ROBERT S. INGOLS**

Sanitary engineering is of considerable importance to this and every region, and in recognition of this fact THE RESEARCH ENGINEER, since its inception, has been publishing a series of articles on welding hazards, industrial dusts, techniques of water and sewage analysis, and industrial wastes. The following article describes the laboratory facilities which have recently been completed here for work in this field.

Georgia Tech's new Sanitary Engineering Laboratory is a vital component of this institute's teaching and research program in sanitary engineering and chemistry. At the present time, because of limiting endowments, it is being used almost entirely for a research project on "Rapid Analytical Techniques of Water and Sewage Analysis," of particular importance because the correct analysis of representative samples is essential to the solution of all sanitary engineering problems. In the future, however, it will be possible for this laboratory to handle many more problems in sanitary engineering.

As part of the present study of the basic techniques of analysis, the laboratory has obtained the basic instruments and reagents which are needed to analyze water, sewage, industrial wastes, and polluted atmospheres. Samples of water, waste, or air may be collected in a plant or from a stream and brought to the laboratory, or actual operating conditions may be produced in model or pilot plant studies.

Laboratory construction was begun in October, 1946, and limited operation was initiated in March, 1947, although full-scale operation was not reached for several months. Since that time, the staff has consisted of three full-time workers and several part-time student assistants.

MAIN LABORATORY

The Sanitary Engineering Laboratory is located on the first floor of the Civil Engineering Building and occupies 200 square feet of floor space. The main room contains most of the routine apparatus, while certain special apparati that are affected by temperature are located in a 12-foot x 6-foot constant-temperature room; these laboratories are shown in Figures 1 and 2. The main laboratory is equipped with chemical work benches built in small units to facilitate the necessary changes for different research programs. In addition, it contains numerous cabinets, refrigerator, hood, still, sink, muffle oven, etc., as well as the necessary utility outlets. The constant-temperature room is quite large, with many movable shelves and utility connections. Both spaces have general and spot fluorescent lighting.

As mentioned, this new equipment is currently being used to solve various problems in analysis, and one manuscript on the determination of calcium has been accepted for publication by the American Chemical Society, while another paper has been published on an "oxygen consumed"

Figure 1. Partial view of the main sanitary engineering laboratory.

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** *Research Associate Professor of Chemistry.*

technique. Although some analytical procedures can be used to test different samples, in general, various modifications must be made to adapt a good procedure to a specific problem. Many of the common methods of analysis have already been modified and codified in a book of *Standard Methods for Water and Sewage Analysis.** Moreover, in order to take advantage of the advances in analytical techniques, the book has already been revised nine times, and it is the intent of the Standard Methods of Analysis Committee of the American Public Health Association to continue this revision at five-year intervals.

In a field where standard methods have been codified, it becomes necessary to test all new techniques against the accepted method or methods, in addition to comparing with theoretical standards where these are available. This means that a research laboratory in this field must be equipped with material to run all of the "standard methods" to be studied in addition to having the instruments needed in the search for new procedures.

* *Standard Methods for Water and Sewage Analysis*, 9th Ed., American Public Health Association, New York, 1946.

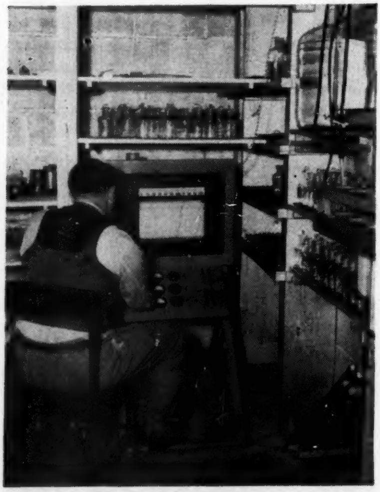

Figure 2. Reading the recording potentiometer in the constant-temperature room of the sanitary engineering laboratory.

METHODS USED

All of the various methods of analysis are being used for studying some of the many components in water or sewage. Gravimetric procedures are the most accurate, but they are also the most tedious, and many have been dropped from the later issues of *Standard Methods* when alternatives were developed. However, the Sanitary Engineering Laboratory is fully equipped to handle many different types of gravimetric procedures, especially since it is felt that the design of some new equipment may reduce the time required for their completion. For example, the common Gooch crucible has been modified here by using a paper mat instead of asbestos for speeding up and increasing the accuracy of two procedures under study.

Volumetric techniques have been widely used for a long time, and there are many valuable methods of quickly obtaining the correct values of the component under study. With today's new electronic aids to titration, moreover, the analysis may be either faster or more accurate, as the problem may dictate. Furthermore, advances in organic chemistry have developed new indicators which give better end-points to the classical titrations.

The use of colorimetry in analytical techniques has accelerated many analytical procedures. With today's highly developed photoelectronic equipment, some of the personal errors have been eliminated, and many elements or radicals can be determined in a matter of minutes. By using sensitive, electronic recording devices, the progress of chemical reactions can now be timed automatically if a suitable indicator can be found. Many of the aids which are now available to the analytical chemist have been gathered into this laboratory for the development of new techniques for control of water and sewage plants and for use in related fields.

Some of the specialized equipment for these analyses are an electronic recording potentiometer (shown in Figure 2); the

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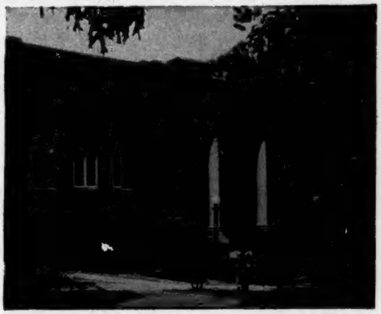
REPORT FROM THE LIBRARY

By DOROTHY M. CROSLAND*

In the fall of 1944, when President Van Leer appointed a committee from the faculty to study the needs of Georgia Tech and to make plans for future development, a new library was near the top of the list of the new buildings which this committee felt were most needed on the campus. In the spring of 1945, there were some who thought that a new library building would become a reality by 1949. The months of 1948 are speeding fast, however, and hopes for a new building in the next few years are fading. If only the committee that made the "Advanced Planning Report" could have offered ways and means of financing the plans!



A library building that can provide adequate space for student and faculty use, for storage of books and journals, and for the preparation of library materials has become almost a dream. The small building opened in October, 1906, is doing a poor job of rendering service to a student body of some 5,000. The contents of the building cannot be used to their fullest extent because of the inadequate space. These contents are valuable not only to the students and faculty of Georgia Tech, but also, potentially, to all research workers of the South. However, the present library building is a fire trap, and if its contents were destroyed by fire, they would be irreplaceable.

It would therefore be a gross understatement to say that a new library building is a necessity if the obligations of the Institute to its students and faculty are to be fulfilled and if Georgia Tech is to offer its library resources to the industrial development of the South. A wealth of research materials are stored in the Georgia Tech Library — journals and books which are to be found in no other library in the South. If these materials were adequately housed, the library could render more valuable services to research. Among present activities is the filling of requests for photostats of articles in various journals, sent in by research workers in numerous Southern industries. Prompt photostats of such articles are available through the Photographic Laboratory of the Engineering Experiment Station. Some of the firms that have requested and received photostats through the library are: Chemical Products Corporation, Cartersville, Ga.; Union Bleachery, Greenville, S. C.; Plantation Pipe Line Company, Bremen, Ga.; Brown Oil and Chemical Company, Jacksonville, Fla.; Mothimune Laboratories, Durham, N. C.; Georgia Power Company; Southern Bell Telephone Company; and the Coca-Cola Company.

Libraries in the following companies and universities have borrowed books and periodicals on the interlibrary loan plan; Air University, Maxwell Field, Ala.; Carbide and Chemicals Corporation, Oak Ridge, Tenn.; Callaway Institute, LaGrange, Ga.; West Point Manufacturing Company, Shamut, Ala.; Research Center, U. S. Waterways Experiment Station, Vicksburg, Miss.; Shell Oil Company, N. Y.; Institute of Textile Technology, Charlottesville, Va.; U. S. Department of Agriculture, Washington, D. C.; Chemical Corps Technical Command, Maryland; Alabama Polytechnic Institute; University of Alabama; University of Texas; and others too numerous to list.

* *Librarian, Georgia Institute of Technology.*

From the nature of the firms that have requested information, books, periodicals, or photostats, one can see how valuable this library already is to Georgia and the South. It would be possible, with adequate financial support and with adequate space for the use of the books and periodicals, for the Georgia Tech Library to become a reservoir for printed engineering and scientific materials for the South.

The book collection alone already numbers almost 100,000 volumes, including those items not yet catalogued, and the current periodical subscription list totals over 1,700. Journals are received from all over the world.

The periodical collection is the backbone of the library. Some of the important journals that have begun publication within the last few years and which may be found on the library shelves are: *Acta Chimica Scandinavica; Acta Crystallographica; Air University Quarterly Review; American Association of Textile Technologists — Papers; Annales de Radioelectricite; Applied Mechanics Review; Applied Scientific Research; British Scientific Research Association, Bulletin; Chemical Engineering Progress; Communications on Applied Mathematics; Engineering Materials and International Power Review; Excerpta Medica, Section 4 — Medical Microbiology and Hygiene; Experientia; Frosted Food Field; Industries des Plastiques; Interavia; Intermediaire des Recherches Mathematiques; Microtecnic; Journal des Textiles; Makromolekulare Chemie; Petroleum* (London); *Refrigeration Journal* (Australia); *Research; Revue de L'Institut Francais du Petrole; La Television Francaise; Television Society, London, Journal; Society of Instrument Technology, Transactions; Technik und Wirtschaft* (Fach, Austria); *Technique Moderne Aviation;* and *Tung World.*

The library is a depository for the following materials: The Radiation Laboratory Reports from the Massachusetts Institute of Technology; many reports from the Office of Scientific Research and Development; maps from the Army Map Service; patents vested with the Alien Property Custodian; the Air Materiel Command card index; FIAT, Review of German Science, 1939–1946; and Die Dissertationen der Eidgenossischen Technischen Hochschule, 1909–date. The library receives current copies of all United States patents, as issued, and the *Abridgements of Patents* of the Patent Office, London. The *New York Times* is received daily and also monthly on microfilm. A new Recordak reading machine was purchased during the past year. Six libraries in the South are participating in the Farmington Plan, which is a plan for the acquisition of foreign library materials. Georgia Tech is among the six and will be responsible for the acquisition and cataloguing of materials on textile industries.

The library continues to add to its collection of scientific and technical journals. Some complete files have been purchased, and many volumes missing from files that are incomplete have been added. The following journals have had volumes added or are complete on the shelves: *American Philosophical Society, Transactions; Annee Aeronautique* (Paris); *Asbestos; Association of Official Agricultural Chemists, Journal; Biochemisches Zeitschrift; Chemicals; Concrete and Constructional Engineer* (London); *Edinburgh Mathematical Notes; Engineering Institute of Canada, Transactions; Hoppeseyler's Zeitschrift fuer Physiologische Chemie; Ice and Refrigeration; Ingeniorsvetenskapsakademien; Institution of Civil Engineers, London, Selected Engineering Papers; Marine Engineering and Shipping Review; Mecanique* (Paris); *Psychological Abstracts; Quarterly Journal of Mathematics; Revue d'Optique* (Paris); *Revue General des Sciences Purees et Appliquees; Royal College of Science, London, Scientific Journal; Wissenschaft und Technik; Stahl und Eisen;* and *Zeitschrift fuer Metallkunde.*

All of these acquisitions have been made for the more serious student, for the graduate student, for the faculty members, and for the research workers. In addition, the library is responsible for the reading program of the undergraduate students, the freshmen and sophomores. Many current fiction and nonfiction titles have been added. Old and worn volumes of standard titles

Continued on Page 22

RECENT FACULTY BOOKS

The writing of scientific and technical books by members of the faculty of an engineering institution is, in a sense, a measure of the achievement level of both faculty and institution, provided, of course, that the books themselves are of good quality and serve their stated purposes. During the past year, two books written by Georgia Tech faculty members have been published, on widely different subjects. One is intended primarily for educational purposes, the other for research and economic reference. It is the hope of the Georgia Institute of Technology that these books will be followed by many more noteworthy volumes written by Georgia Tech authors in the years to come.

Alan Pope, *Wind Tunnel Testing*. John Wiley and Sons, New York, 1947. 319 pages. $5.00.

In the dark ages of aviation, back when the Air Force was a branch of the Signal Corps, aerodynamics was a science comparatively untouched by research. Today, however, it is a field of engineering science which is of interest to student and industry alike. Simultaneous with the growth of this interest has been the development of technological equipment from which the student learns the practical and graphical applications of his chosen field, and with which the wind tunnel researcher gains the required data.

Wind Tunnel Testing by Associate Professor of Aeronautical Engineering Alan Pope is the first integrated text on the subject of wind tunnels, and is designed to cover both the design and operation of a wind tunnel and the interpretation of the data. The practical background for this work was gained by the author during teaching of wind tunnel courses at Georgia Tech and five years of operation of the large Georgia Tech wind .tunnel.

The book was written to serve a threefold purpose: (1) to be employed as a text or reference book in a basic college wind-tunnel course, (2) to serve to guide the aerodynamicist in designing small tunnels, and (3) to serve as a basic reference for the embryo wind tunnel engineer. Intelligible to both undergraduate and graduate students, the book requires only college calculus for working knowledge. Early chapters cover types of wind tunnels and design procedures for low-powered wind tunnels. Several chapters then cover the calibration of the tunnel, the auxiliary equipment, and, finally, testing procedures. The remaining chapters discuss the extrapolation of the data to full scale. Numerous examples make the interpretation of the information simple and direct.

Professor Pope's book has been well received by the industry and by colleges. Copies may already be found in nearly every wind tunnel, and the book is being used as a text by a large number of these engineering colleges which have wind tunnel courses.

B. H. Weil and John C. Lane, *Synthetic Petroleum from the Synthine Process*. Remsen Press Division, Chemical Publishing Co., Inc., Brooklyn, 1948. 303 pages. $6.75.

Petroleum is literally the life-blood of the nation. It powers our highway vehicles, airplanes, and Diesel trains; lubricates our countless machines; and supplies a multiplicity of other products needed in industry and in homes. It is little wonder, therefore, that the subject of future supplies has long received close scrutiny from all concerned and that much research has been performed on the synthesis of petroleum substitutes from other and more abundant substances.

Among the various methods which have received study is the Synthine (Fischer-Tropsch) process, which involves the preparation of hydrogen-carbon monoxide "snythesis gas" from natural gas, coal, or other suitable materials and the conversion of this gas into synthetic petroleum and other products. *Synthetic Petroleum from the Synthine Process* is the first book ever written on this subject, and its timeliness is evident from the fact that two plants using the process are already under construction and several others are being considered.

The book is based on detailed literature and patent studies made by the authors in

connection with their work in the petroleum refining field. Under four main sections — synthesis gas, the catalytic synthesis, products and by-products, and basic economics, the authors have discussed the various aspects of the subject in considerable detail, and have documented their discussion with reference to over 400 original sources. The several appendices should be of great value to the serious worker in this field, for they contain a complete list of all patents on the process phases, an indexed list of Government-released Synthine reports, and a supplemental bibliography of recent references.

This book was written by Research Professor B. H. Weil, Chief of the Georgia Tech Engineering Experiment Station's Technical Information Division, and Mr. John C. Lane of the Institute of Gas Technology. It should be of real value to the theoretical organic chemist as well as engineers and others who are interested in the technological aspects of synthetic fuels and those chemicals now derived from petroleum. Ramifications of the Synthine process are too numerous to mention here in detail, but there seems little question that it will find much future use and that this compendium of available information will aid those working on its development and commercial application.

ENGINEERING DESIGN AS RESEARCH IMPLEMENT

Continued from Page 4

designed to eliminate the troubles that were encountered when these planters were operated at high speeds.

The original experimental machine was completed in 1946 and delivered to the Georgia Agricultural Experiment Station for field tests in that year. Results of these tests, while proving the principle to be satisfactory, naturally suggested several improvements which could be made in the original model. These changes were agreed upon in a meeting between representatives of the Agricultural and Engineering Experiment Stations, and the design of a second model was begun. The planting mechanism was essentially the same as that used in the original model, but was redesigned to permit ready access to all portions for cleaning and for changing the pick-up belt to accommodate various types of seeds. Figure 2 shows the improved model.

At the same time, considerable thought was given to the tractor connections, particularly for multiple-row planting. For this purpose a light-weight steel framework was provided which could be readily attached to the hydraulic lift of a conventional tractor. This framework carries a rotating transverse shaft, driven by a chain from a sprocket on the rear wheel of the tractor. The shaft serves two purposes; first, it provides the means for attaching several planters side by side (up to a maximum of four), and second, it acts as a drive for the planting mechanisms through a chain and sprocket connected to each machine. This represents a change over the original model which was driven by the presser wheel. It was made in order to eliminate unequal seed spacing due to bouncing of the presser wheel at high speeds over rough ground. However, a problem was created in that the planting mechanism had to be disconnected when the machines were elevated by the hydraulic lift. This was overcome by the use of a jaw-type clutch which automatically disengages the drive shaft as the planters are elevated.

Variations in row spacing to a minimum of 12 inches are made possible by a series of holes in the lower member of the attachment frame which permit the planters to be connected at any point. Each connection consists of two sleeves, ten inches apart, on the transverse shaft, so that the planters are prevented from side sway or overturning, yet are free to pivot vertically about the shaft when uneven ground is traversed. This travel is limited to approximately eight inches by means of elevating

chains which are normally slack, but take the weight of the planters as they are lifted clear of the ground.

At the present time, four of the improved planters are under construction at the Engineering Experiment Station. These will be mounted on a standard farm tractor for additional planting tests this year. It is believed that this machine will prove to be of great value to Southern agriculture when produced on a commercial scale.

MECHANICAL EQUIPMENT FOR RESEARCH PROJECTS

The development of the mechanical equipment, needed by workers for research on a given project, while comprising only a portion of the total effort represented by that project, is nevertheless a very important part of the services rendered by the Station's Engineering Design Division. The very nature of research requires the use of many pieces of equipment of new and radical types. Frequently, this equipment is not available and must be designed and manufactured within the Station itself, from specifications which are dictated by the particular problems involved. While this sometimes means that the resulting device may be the only one made, it may be of vital importance to the program as a whole.

The current project on the preservation of foods by freezing[4] provides a typical illustration. This program, sponsored jointly by the Tennessee Valley Authority and the Engineering Experiment Station, has been under way for approximately two years and includes the construction of a complete pilot plant for the quick freezing of fresh fruits and vegetables as part of its work. The operation of this plant is unique in that the food will be prepackaged in individual wire-mesh containers and will move in assembly-line fashion from the time it enters the plant until it is placed in cartons ready for refrigerated storage.

When the idea of continuously moving containers was initially considered, it became apparent that centrifuging of the food following the quenching and immersion freezing operations presented a serious problem unless some means were employed other than the conventional type of dryer (centrifuge). These machines are charged while at rest, slowly accelerated to a maximum rate of revolution, then decelerated and stopped for discharging.

Figure 3. General view of experimental centrifuge.

Here, however, the requirements called for a machine which could be charged and discharged *while operating at full speed.* This result was accomplished by means of a unique design in which eight wire-mesh containers are whirled about a hollow central pedestal at a radius which slowly varies from zero to a maximum of 36 inches as two slowly counterrotating frames or "spiders" revolve; this device is shown in Figure 3.

Charging and discharging are accomplished simultaneously as each container comes into position above the central pedestal, one container being automatically ejected as the next is inserted. In the experimental machine constructed here, the rate of discharge can be varied up to a maximum of three one-pound containers per minute. At this speed, each container remains in the centrifuge for approximately three minutes while being subjected to a slowly increasing centrifugal action until a limit of 334 times gravity is reached, after which the acceleration is gradually reduced, reaching zero at the point of discharge.

As was the case with the seed planter, operation of the original centrifuge has indicated improvements which can be made. These will be incorporated in future designs, although the present machine will be used in the pilot program.

It is also evident that it need not be limited to frozen food production, but will find application in any continuous process wherein a centrifuge is required.

SPECIALIZED SCIENTIFIC APPARATUS

Many of the highly specialized pieces of laboratory apparatus used in the various departments of Georgia Tech have been designed and built at the Engineering Experiment Station. These vary from delicate pieces of electronic equipment to hydraulic testing machines which are capable of crushing concrete blocks. In this manner, it has been possible to provide for the construction of apparatus designed to fulfill the specific requirements of each laboratory, making it unnecessary to adapt existing standard equipment (if available) to meet these needs in a less satisfactory way.

Not infrequently, the specifications call for accuracy of workmanship or special techniques which are impossible to obtain except through a close liaison between the designer and shop worker. This is made possible by a flexible organization that permits direct contact between these men whenever necessary. It also allows the man who will make use of the equipment to follow its progress during construction and to make any revisions that may seem advisable. This is a distinct advantage when relatively new or unusual types of apparatus are designed.

Perhaps the best example of this work is a small flume recently completed for the Georgia Tech Hydraulics Laboratory. This device, shown in Figure 4, is essentially a glass-walled channel of rectangular cross section through which water can be made to flow under closely controlled conditions. Since it is strictly a piece of laboratory apparatus, its construction required a high degree of accuracy, although it is fabricated from standard steel plates, angles, and channels which are ordinarily associated with construction wherein large tolerances are permitted.

In order to produce a rigid structure, the lower portion was made in the form of a welded box truss, approximately 24 feet long, 15 inches wide, and 30 inches deep. To this the forebay and tailbay sections were welded, as these portions do not require the accuracy of the working section. Next, the steel bottom plates were machined so that their edges were square and parallel. These were bolted to the welded framework, and shims were added where necessary to insure a smooth floor within $\frac{1}{32}$ inch of a

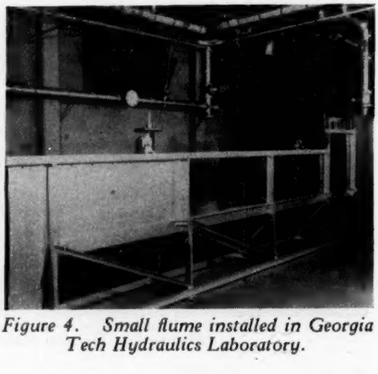


Figure 4. Small flume installed in Georgia Tech Hydraulics Laboratory.

true plane. It was decided to bolt all connections in the glass-walled working section, as the heat of welding during assembly would have distorted the metal plates and angles.

The design of the sides presented quite a structural problem. Since a maximum of visibility was required, the vertical glass-supporting members had to be made as slim as possible, yet sufficient strength had to be maintained to resist the pressure of the water without appreciable deflection. To increase the difficulty, it was not permissible to use cross members at the top to tie the sides together.

After several preliminary designs were considered, the uprights were made of high-strength steel bars of one-inch by three-inch rectangular cross section, bolted at their lower ends to the welded framework. To these were attached the steel retainer angles which press against the glass side panels. In this way, a mullion was produced having a total width of only three inches without sacrifice of strength.

In the working section, the side panels were made of tempered plate glass ⅝ of an inch thick. These were held in place by the steel retainer angles and waterproofed with fibrous asphalt material between all faying surfaces. Tolerances in this section were held to within $\frac{1}{32}$ inch of dimensions desired, and the floor plates were accurately leveled on installation.

In addition to the structural problems, there was also the question of corrosion to be considered. As the water used in the flume is continuously recirculated, it becomes extremely aerated. This greatly accelerates the rusting of all exposed steel parts, especially where water is trapped in small crevasses. In order to combat this, all joints were carefully painted with chromate primer before assembly, and no porosity was permitted in interior water-tight welds. Finally, the completed flume was given two coats of aluminum paint to match existing laboratory equipment.

At the present time, this flume is in regular operation in the hydraulics laboratory at Georgia Tech. It is used primarily for student instruction, thereby making available a larger flume for research work.

DEVELOPMENT OF PATENTED DEVICES

The facilities of the Engineering Experiment Station are frequently made available to properly qualified sponsors who are interested in the development of mechanical devices which are already patented but are not perfected to the extent of being of commercial value. In these instances, considerable detailed design is usually necessary in order to adapt the device for manufacture by standard methods and to insure that its operation will be as claimed. Following this, a certain amount of shop follow-up is required during construction to check the work against the drawings and to make such revisions as may seem desirable.

At the conclusion of the work, the sponsor is supplied with copies of all pertinent drawings and work sheets, usually in the form of a final report prepared by the Engineering Design Division. In addition, the rights to any improvements which may have been made in the original patent are usually assigned to the sponsor.

An interesting project of this nature was the development of an automatic self-basting roaster from the patent drawings supplied by its inventor. This device consisted essentially of a conventional roaster, the bottom of which was provided with one or more depressions or "wells" in which the gravy was collected. In each well was placed the lower end of a small tube having its upper end directed inwardly toward the meat. When the roaster was heated, the tube or tubes acted as percolators, so that a continuous basting action was provided as long as heat was applied.

As originally conceived, the roaster was to be made in two types, one to be used in an oven or on top of a stove, and the other to be heated with self-contained electric units.

In order to facilitate the work, several conventional stove top roasters were purchased and modified by the addition of basting wells of various diameters and depths, until an optimum design was reached. Basting action was found to be very satisfactory as long as heat was applied directly to the bottom of the wells. The addition of grease and solids to the

fluid seemed to have little effect upon the percolation when heated from below. No clogging or stoppage of the basting tubes was encountered in any of the tests. However, when the roaster was placed in an oven, percolation could not be obtained, even though the temperature was raised to 300° F., since the resulting evaporation did not produce sufficient steam bubbles to operate the basters. For this reason, the idea of an oven-type roaster was abandoned, and further efforts were directed toward the development of an electrically heated model.

Accordingly, a large roaster was constructed from 20-gauge sheet metal, complete with a steel lid and rack, as shown in Figure 5. This roaster was circular, 14 inches in diameter by 9 inches deep, with a single basting well 2¼ inches in diameter by 1½ inches deep, located on the bottom periphery. A basting tube approximately 12 inches long extended to the top of the roaster. The electric heating units were located in a separate base 14 inches in diameter by 4 inches high, containing two elements rated at 500 watts and 1000 watts, respectively. These were separately connected to two control switches, so that either could be operated independently of the other. The larger element was located under the center of the roaster and was used to provide cooking heat, while the smaller element was located directly under the basting well and provided heat for basting only. A special thermostatic switch permitted control of the basting action by providing an intermittent heat which could be varied by means of a dial setting.

The entire roaster was then plated, the base was finished in black wrinkle enamel, and black plastic handles were attached to the sides and lid. A set of operating instructions were then prepared and submitted to the sponsor, along with a final report. This report contained, in addition to a complete record of all work done, recommendations for future development of the roaster on a commercial scale.

* * * * *

Although the foregoing are typical examples of the variety of mechanical design work which is undertaken at the Engineering Experiment Station, they do not clearly reflect the efforts of the many people who have made signal contributions through their knowledge of science and engineering. Without the valuable assistance offered by the various specialists on the Station's staff,

Figure 5. Electrically heated automatic self-basting roaster. Disassembled parts are shown at right.

as well as by members of the Georgia Tech faculty, much of the work done by the Engineering Design Division would have been impossible.

Many other projects in the field of mechanical design and development have been performed here at Georgia Tech. Devices developed include a portable photofluorographic X-ray machine,[2] a stereoscopic viewer, a bottle-marking machine, a stock-weighing scale, a transfer bar, and a tire gauge.

Engineering design work is but one phase of the over-all program of the Georgia Tech Engineering Experiment Station, but it is a type of endeavor essential to the efficient conduct of many research projects, and, at least in intent, valuable to this region in the solution of problems involved in the commercialization of new devices. The Station's motto and goal for this region, "Supremacy Through Research," can be forwarded only by the joint action of all Station divisions.

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SOIL MECHANICS

Continued from Page 8

lathes have been designed to shape cohesive soils for the triaxial tests. These lathes hold a block of soil in a vertical position between two rotating Lucite disks while it is being trimmed into a cylinder by a wire "cheese knife."

Compressibility testing devices (consolidometers) are available for different soil sample sizes. A unique, simplified model has been developed to facilitate mass production testing of soils without sacrificing accuracy. The soil sample is encased in a stainless steel ring and is compressed by porous bronze disks (mounted on Lucite) that permit free drainage of water from the sample.

Undergraduate soil mechanics instruction at Georgia Tech is designed for the engineer who is not preparing to be a specialist in that field. All civil engineering students are required to take one course involving three hours of lecture and three hours of laboratory per week. The lectures emphasize an understanding of the physical properties of soils, the nature of soil mechanics, and a rational approach to foundation analysis. The laboratory work involves soil sampling and testing, soil classification, and some problems in design.

Advanced soil mechanics is offered in two courses open to seniors with high standing and to graduate students. In these courses, the engineering properties of soils are covered in detail, and the application to foundations, dams, retaining walls, deep excavations, and similar problems is studied. Additional courses in advanced soil mechanics will be added as demand warrants. Special problems and study courses are available for graduate students who wish further study in some particular phase of soil mechanics.

RESEARCH OPPORTUNITIES

Many problems remain unsolved. Research involving the physical properties of soils requires years of experiment, highly trained personnel, and expensive equipment. Much of this research is currently being performed in several governmental laboratories and in a few colleges, under government contract.

There are many unsolved problems of practical importance, however, that can be handled by newer laboratories, such as the one here at Georgia Tech. These involve studies of the empirical rules governing the construction of embankments, foundations, dams, excavations, and other structures, and the development of simple, rational methods of design.

Three research projects of this nature are in the planning stage at present. The first

involves a study of field load testing for bearing capacity of foundations. A simple truss frame has been constructed that applies a load to the soil through a calibrated hydraulic jack. The jacking reaction is supplied by four earth-anchors of the type used for anchoring guy wires. A second project involves the preparation of undisturbed samples suitable for laboratory testing in even the softest soils. The third project involves seepage of water through earth dams and levees. A new technique involving viscous liquids, such as glycerine, will be used to represent two-dimensional flow of water through soil.

Civil engineers and contractors in this country are giving more and more attention to the material on which their structures rest — the soil. The study of its properties and mechanics in the new Georgia Tech Soil Mechanics Laboratory should, it is hoped, contribute to the advancement of knowledge in this field and to the training of engineers in the science and methods involved.

WHAT'S IN A NAME?

Continued from Page 2

The GEORGIA TECH NATIONAL ALUMNI ASSOCIATION, as its name implies, is an organization created specifically to maintain contact between Georgia Tech and its alumni and to serve the alumni in various ways.

The TECHNICAL INSTITUTE, a unit of the Georgia Tech Engineering Extension Division, is designed to train technical personnel for specific positions in industry, rather than for the broad aspects of engineering practice. Its course of study is of two-year duration.

It may seem confusing to have institutes with an institute or associated with it, but it must be remembered that there are only a few broad terms which can apply to educational organizations of wide scope and purpose. "Institute," "foundation," "school," "college," "department," "division," and "section" practically exhaust the vocabulary of the field.

In any event, Georgia Tech is now an "institute," a term which seems more appropriate to its broad purposes than did the title "school." The Georgia Institute of Technology now joins an illustrious group of technological institutions of higher learning which employ this term in their official titles. Notable among these are the Massachusetts Institute of Technology, the California Institute of Technology, the Carnegie Institute of Technology, the Illinois Institute of Technology, etc. The initials may be changed — some of our veterans now refer to us as "G. I." Tech — but to the general public we will continue to be known as "Georgia Tech."

LIBRARY REPORT

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have been replaced by new and attractive editions. Some volumes for recreational reading have been placed on the shelves for new books.

It is hoped that the facilities and services of the Georgia Tech Library will some day be available to all research workers and students of this region. To give efficient service to the students and faculty members is impossible at the present time, however, so it is therefore more than impossible to try to give effective service to others. All available space has been used for shelves. Many books and periodicals are being packed for storage, because of lack of space. The space for student use is more than inadequate; during the past year, students have actually had to sit on the steps and on the floors, while others have worked at low book shelves. Yes, a new library building is a necessity if Georgia Tech's obligations to its students and faculty members are to be fulfilled.

SANITARY ENGINEERING

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Burrel gas analyser, which can be used for determining percentages of H_2, N_2, O_2, CH_4, C_2H_6, CO, and CO_2 in sewage or other gases; and the direct-oxygen-demand apparatus which, in effect, measures the respiration or breathing of sewage or waste.

The basic units of these instruments have been obtained commercially, although occasionally it has been deemed desirable to design and to build new apparatus, such as the infrared ray drier shown in Figure 3.

Analysis of polluted air is becoming increasingly important. The contamination of an industrial atmosphere by toxic dusts or noxious gases, vapors, or mists is of real importance to industry from the standpoint of employee health. Inasmuch as the dangerous concentrations of dusts or gases are very low, specialized techniques must be used for their accurate determination. For dust collection, the laboratory is equipped with impingers and an electric precipitator (Figure 4). To check the concentration of carbon tetrachloride or hydrocarbons in the air, the combustion analyser also shown in Figure 4 may be used. In addition to this specialized apparatus, the laboratory is equipped with a variety of flow meters to assist in pilot and field studies. Much of the atmospheric analytical equipment is portable.

This laboratory and its staff are interested both in the improvement of routine techniques and in the development of new procedures for special problems. Through research and teaching, they hope to serve this area in the fields of water, sewage, industrial wastes, and industrial hygiene.

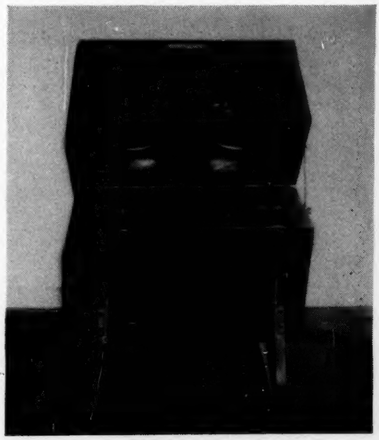

Figure 3. Georgia Tech-built infrared dryer.

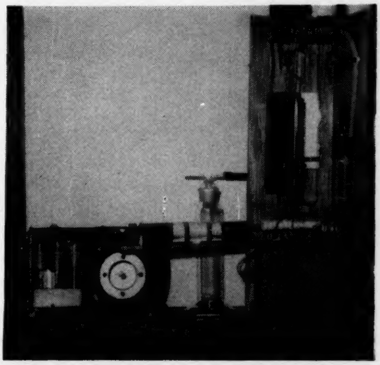

Figure 4. Combustion analyzer, impingers, and electrical precipitator, field instruments employed in the analysis of polluted atmospheres.

EXPERIMENT STATION

Continued from Page 10

tions, and individuals at Georgia Tech who need such work in connection with their research and educational activities. Such other services will be offered as are needed and as finances permit.

Because of a shortage of funds, it became necessary during the year to discontinue operation of the INDUSTRIAL ECONOMIC RESEARCH STAFF, following the resignation of its chief research fellow. Only one study, on the economic aspects of the naval stores industry, was prepared. Economics, especially industrial economics, cannot be neglected by any engineering experiment station, and it seems vital that this group be reactivated in the near future.

PUBLICATIONS

Progress reports on several of the Station's projects as well as reports on other activities of its staff were published during the year in the form of bulletins, circulars, reprints, and special reports. Some 18 separate publications were released, and 13

articles describing Station activities appeared in THE RESEARCH ENGINEER. Reports on the progress of 14 other projects or other activities are in the process of preparation for publication. These publications do not represent all of the Station's progress reports by any means, since many projects are of such a nature that publication of results cannot be made. Several patent applications have been filed, based on the work of certain of these projects.

RESEARCH PROJECTS

The number of industrially sponsored projects increased considerably during the year, and continued efforts are being made to expand further the industrial part of the Station's program as well as other phases of its activities. All of the projects performed for industrial sponsors and most of those for other outside agencies were contracted for through the Georgia Tech Research Institute, the details of whose operations were described in the May, 1946, issue of THE RESEARCH ENGINEER.

As mentioned above, many of the projects are conducted in confidence, and details of their results cannot be published until mutually agreed upon by both the Station and the sponsors. Much of the work which can be described has been or will be reported in this journal or in formal bulletins.

Some of the major research programs now in progress deal with food freezing, water and sewage analysis, dry cell technology, vegetable oils, cellulose, chlorination of raw sewage, the properties of matter at very low temperatures, the thermodynamic properties of gases, weed killers, explosives, emulsions, yarn processing, ramie fiber studies, and nylon staple research.

In the field of electronics, an FM survey of the Atlanta area was completed and a study was made of the keying properties of quartz crystal oscillators. In addition, a study of television systems is in progress. Another project is concerned with the correlation of radar measurements with meteorological data, and several projects of a confidential nature are under way.

Numerous projects in the field of mechanical engineering design-development were undertaken. These included development of a multiple-row, high-speed peanut planter, a stereoscopic device for viewing X-ray films, an accurate cattle-weighing scale, a specialized gage, etc.

Over 15 projects were concerned with aerodynamic research and wind tunnel testing. Research was undertaken on the aerodynamics of the "rigid" rotor, solution of equilibrium equations for inclined flight, study of boundary layer flow over an airfoil, the effect of twist and taper of the blades of a helicopter rotor in vertical descent, study of a helicopter wing through the complete angle range, etc.

A list of sponsors is never more than indicative of the breadth of a research program, especially since some cannot be mentioned without undesired revelation of the nature of their work. During 1947–1948, however, the Station conducted research projects sponsored wholly or in part by the following organizations, among others:

Auto-Soler Company, Boeing Aircraft Company, Ben W. Carmichael, Design Development Corporation, E. I. du Pont de Nemours & Company, Fairchild Engine and Airplane Corporation, Georgia Agricultural Experiment Station, A. R. Glancy, Inc., Johns-Manville Corporation, Glenn L. Martin Company, McDonnel Aircraft Corporation, National Advisory Committee on Aeronautics, National Institute of Health, Plantation Pipe Line Company, Print-A-List Company, Quality Refining Company, S. H. X-Ray Company, A. E. Staley Manufacturing Company, Tennessee Valley Authority, several branches of the United States Army and Navy, and the Wallace & Tiernan Company.

The State Engineering Experiment Station of the Georgia Institute of Technology is the engineering and industrial research agency of the University System of Georgia. Through its program of fundamental, applied, and industrial research, it serves to aid directly in the integration of industrial and agricultural facilities and in the better utilization of the natural resources of this region. Encouraging growth has been evidenced in the past, and every effort will be concentrated in the future on serving Georgia, the Southeast, and the nation in every manner consistent with the aims and purposes of the Station.